

Conrad

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March 31, 1958

Dear Dennis:

Enclosed are a few more copies of our ms., with slight revisions. I have also inked in a couple of other points (on copy 1) that may merit polishing.

Do you recall the business about the splitting of grains that we culled from the first draft? There may be more in this than either of us knew then. (See Dufay; Spitzer in *Astrophys. J.*, 1951). The big stumbling block in the theory of grain-building is the rate of the first steps, e.g., $C+H \rightarrow CH$ which, as the free atoms is impossibly slow. There has to be some mechanism by which the number of grains can increase. But although Dufay remarks on collisions giving fusion (low energy impact) or evaporation (high energy) no one has remarked that the fracture of a rare grain (intermediate energy) would give the needed process for increasing the number of nuclei! To this I would add the photochemical rupture too.

So the biological analogy goes one step further: you have to have some pre-existent organized structure to catalyze its further synthesis. What chemical specificity there will be in this is hard to say, but there must be some. As you pointed out the role of the nuclei, of electric charges, of magnetic polarizations, and so on is going to make the chemistry of the grain almost impossible to predict.

I have also had some time to read more about interplanetary material, and especially comets. By Whipple's model, which seems to be the most popular, the comets are very nearly the same as large grains, possibly the drogs from the outer limb of the solar condensation, but at any rate mostly in tremendous orbits around the sun. Perturbations of passing stars are supposed to push some of them into more elliptical orbits where we see them near perihelion. He thinks that cometary debris may contribute even more to the infall (as micro-meteorites) than the macrometeorites which are of asteroidal origin, and have been fractionated rather like the earth. The cosmic C;Ni ratio is certainly a maximum one, and if the asteroidal component is appreciable, the C infall will be grossly exaggerated, but it is just conceivable that it may not be too bad. By the way, infall of C could be used to criticize Harrison Brown's argument that the earth was never hot enough to expel CO_2 . He is probably safer on the O of CO_2 and especially of water: the oceanic water comes to 1.4×10^{24} g -- perhaps this isn't too much for the H, if you are willing to reserve oxygen as oxides to this extent.

Before doing any more about the growth of grains, I'd like to get Spitzer's reactions.

John Pfeiffer called me up Sunday: he wants to write a popular book on evolution and he does mean from the galaxies on down!

What did you think of the Killian report?

Yours,

John

volatile
educible

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